Attosecond UV Pulses Could Control Electrons

LINCOLN, Neb., Dec. 1, 2014 — Elliptically polarized attosecond laser pulses could ionize helium atoms in a controlled fashion, potentially giving physicists control over the freed electrons.

In a theoretical study, an international team led by researchers at the University of Nebraska-Lincoln demonstrated that the angles at which two electrons launch from a helium atom depends on whether a laser pulse has an elliptical electric field that is right- or left-handed.

The researchers also calculated the distinct range of angles at which the electrons depart under both conditions. The team termed the phenomenon “nonlinear dichroism.”

Research assistant professor Dr. Jean Marcel Ngoro Djiokap, left, developed the computer model describing the double ionization of a helium atom by an attosecond UV laser pulse. Professor Dr. Anthony Starace was the lead author. Courtesy of Scott Schrage/University of Nebraska-Lincoln.

Producing this effect in the laboratory would require an intense, few-cycle extreme UV laser with controlled polarization and carrier-envelope phase and pulsewidths of no more than 200 attoseconds.

“If experimentalists can finally produce such pulses reliably, this new effect allows great control over the way electrons move,” said professor Dr. Anthony Starace. “If we hit a target with the short, attosecond pulses that have a particular duration and polarization, we can tell the electrons whether to go one way or another. This is humankind’s dream of controlling electrons, rather than just watching them.”

For now the results will allow theorists to explore the question of how long electron transitions and processes take, Starace said.

Completing the study involved solving the six-dimensional, two-electron, time-dependent Schrodinger equation. The team said its computer model was the first to account for both the interactions between two laser-influenced electrons and the complexity of elliptically polarized electric fields.

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